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MODULAR RADIAL COMPONENT FOR A TOTAL WRIST ARTHROPLASTY

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MODULAR RADIAL COMPONENT FOR A TOTAL WRIST ARTHROPLASTY

Background of the Invention

The present invention relates to wrist prostheses, and especially to prosthesis for a total wrist arthroplasty. More specifically, the invention concerns a modular prosthesis that permits modification in a revision surgery.

In a total wrist arthroplasty, radial and metacarpal components are engaged to the radius and metacarpal bones, respectively. In a common wrist prosthesis, the radial and metacarpal components define an articulating interface that emulates the natural movement of the patient's wrist. In more recent total wrist prostheses, the articulating interface is defined by ellipsoidal joint elements that eliminate problematic axial rotation and limit the articulation along the axes for flexion/extension and radial/ulnar deflection.

As wrist prostheses have evolved, the trend has been toward modularity. This modularity allows a wrist prosthesis to be specifically tailored to a patient's anatomy. Consequently, some prosthesis offer differently sized radial and metacarpal components. For instance, in some implants, as represented by U.S. Patent No. 6,485,520, different articulating elements can be selected, with the selected elements being fastened together with machine screws. Thus, in these prior implants, the benefit of modularity is appreciated only when the prosthesis is initially constructed. These implants cannot be modified in a revision surgery without completely removing the affected arthroplasty component.

Until the last decade, total wrist arthroplasty (TWA) was a rarely used option over wrist fusion because of the difficulty in obtaining long-term fixation of the metacarpal/distal side. Improvements in the design of the metacarpal component have led to increasing favor for TWA. In the typical TWA prosthesis, the modularity is restricted to the metacarpal component. One problem with this approach is that the profile height of the metacarpal component must be prominent in order to accept the modular components. This increased height

increases the lever arm force exerted on the prosthetic joint. This increased force manifests itself in undesirable loosening of the metacarpal fixation, which can require an invasive revision surgery to remove or repair the loosened metacarpal component.

There is a need in the field of total wrist arthroplasty for a modular system that does not suffer from the difficulties commonly associated with current TWA. There is a further need for a modular system in which the benefits of modularity can be capitalized on in a minimally invasive revision surgery or procedure to restore proper joint tension and spacing of the joint components.

Summary of the Invention

These needs are met in the present invention by a total wrist arthroplasty prosthesis that places the replaceable modular elements on the radial side of the wrist joint. In one embodiment of the invention, the radial component includes a platform having a stem configured to be implanted within the radius bone. The platform carries an insert that provides the radial or proximal articulating component for the wrist joint. In one feature of the invention, the platform and insert include mating features that allow for ready attachment of the insert to the platform. In a further aspect, the ready attachment also accommodates ready removal of the insert when necessary to replace the insert in a revision procedure, for instance.

In one embodiment a radial component for a wrist prosthesis comprises a stem configured for engagement within the radius bone and a platform attached to the stem. The prosthesis includes an insert defining an articulating surface for mating with an articulating element of a metacarpal wrist component. In one feature of the invention, a mating feature is provided between the insert and the platform to permit engagement of the insert to the platform and removal therefrom without removing the platform from the stem and without removing the stem from the radius.

In certain embodiments, the mating feature includes mating snap-fit elements defined in the platform and the insert. These snap-fit elements can include a female snap-fit element defined in the platform and a male snap-fit element defined in the insert. The platform can define a recess with an opening sized to receive the insert therein and an undercut defined around at least a portion of the opening. With this embodiment, the insert at least one flexible tab configured to engage the undercut within the opening.

In other embodiments, the insert includes two flexible tabs at opposite ends of the insert that can be depressed to activate the mating features. Each of the flexible tabs can include a wedge surface configured to deflect each of the two flexible tabs as the wedge surface contacts the platform when the platform is

introduced into the recess. To facilitate insertion and removal, the insert includes means for engagement by an insertion tool, which can be a pair of recesses defined on opposite ends of the insert.

In a further embodiment, the insert defines an inner flange around at least a portion of the insert, and the platform defines a recess with an opening sized to receive the insert therein. The platform further includes at least one flexible tab configured to engage the inner flange when the insert is within the recess.

In other embodiments of the invention, the mating feature includes a first slot extending through the insert, and a second slot extending through the platform, the first and second slots opening toward each other when the insert is engaged to the platform. An opening defined in the platform in communication with the second slot and aligned with the first slot when the insert is engaged to the platform is configured to receive a pin configured to alternatively extend through the second slot and through the opening and the first slot. The first slot and the second slot are preferably angled relative to each other.

In yet another embodiment, the mating feature includes an opening defined in the platform, a recess defined in the insert and arranged to align with the opening when the insert is engaged to the platform, and a locking member pivotably disposed in the opening and configured engage the recess when the locking member is in a locking position and to disengage the recess when the locking member is not in the locking position. In this embodiment, the locking member is eccentrically mounted within the opening and includes a cam surface configured for engaging the recess.

The invention further contemplates a method for implanting a radial component of a wrist prosthesis. This method comprises the steps of implanting a platform in the radius bone, and engaging an insert to the platform when the platform is implanted in the radius bone, the insert defining a bearing surface for mating with an articulating element of a metacarpal wrist component. In another method of the invention, an insert is removed from the platform while the platform is engaged in the bone, and another insert is engaged to the platform.

It is one object to provide a wrist implant that provides the removable modular feature on the radial, rather than the metacarpal, component. It is another object to provide a joint implant that incorporates mating features that permit ready removal and engagement of a bearing insert with a component supported on the bone.

These and other objects and benefits of the invention will be appreciated from the following written description, taken together with the accompanying figures.

Description of the Figures

FIG. 1 is a side view of a total wrist arthroplasty (TWA) in accordance with one embodiment of the invention.

FIG. 2 is an exploded side view of the radial component of the TWA shown in **FIG. 1**.

FIG. 3 is an enlarged perspective view of the insert forming part of the radial component shown in **FIG. 2**.

FIG. 4 is an end view of the insert depicted in **FIG. 3**.

FIG. 5 is an enlarged side partial cross-sectional view of the radial component shown in **FIG. 2**, with the insert attached to the platform of the component.

FIG. 6 is an end view of the radial component illustrated in **FIG. 2**.

FIG. 7 is a top view of a tool for use in attaching or removing the insert to or from the platform.

FIG. 8 is a side partial cross-sectional view of a radial component in accordance with a further embodiment of the invention.

FIG. 9 is a perspective view of an insert for the radial component according to a further embodiment of the invention.

FIG. 10 is a partial side cross-sectional view of an alternative embodiment of a radial component according to the present invention.

FIG. 11 is a partial enlarged cross-sectional view of a radial component in accordance with an embodiment of the invention that utilizes a separate element to engage the elements of the radial component.

FIG. 12 is a top view of the radial component shown in **FIG. 11**.

FIG. 13 is a partial enlarged cross-sectional view of the radial component according to another embodiment of the invention, with a separate locking element shown in its unlocked position.

FIG. 14 is partial enlarged cross-sectional view of the radial component shown in **FIG. 13**, with the separate locking element shown in its locked position.

Description of the Preferred Embodiments

For the purposes of promoting an understanding of the principles of the invention, reference will now be made to the embodiments illustrated in the drawings and described in the following written specification. It is understood that no limitation to the scope of the invention is thereby intended. It is further understood that the present invention includes any alterations and modifications to the illustrated embodiments and includes further applications of the principles of the invention as would normally occur to one skilled in the art to which this invention pertains.

A total wrist arthroplasty (TWA) **10**, shown in **FIG.1**, includes a radial component **12** and a metacarpal component **14**. The metacarpal component **14** can be configured in a known manner to engage certain metacarpal bones of the hand. The component includes an articulating element **15** that can follow known configurations. In particular, the element **15** can preferably be in the form of an elliptical male component of the TWA joint.

The radial component **12** can include a platform **18** with a stem **20** projecting therefrom. The platform and stem are configured for implantation in the radius bone in a known manner. The radial component **12** further includes an articulating insert **22** that provides the joint interface with the articulating element **15** of the metacarpal component **14**.

As shown best in **FIGS. 2-4**, the insert **22** defines a bearing surface **35** that is shaped for sliding and pivoting contact with the articulating element **15** of the metacarpal component **14**. As is common for TWAs, the insert **22** can be formed of a polymeric material, such as polyethylene, that serves well in providing a smooth bearing surface **35**. Other materials are contemplated, provided they exhibit the same characteristics for sliding/rotating contact with the metacarpal articulating element. For instance, the insert **22** can be formed of a ceramic or a metal.

In order to accept the insert **22**, the platform **18** defines a recess **26** with a support edge **24** at the recess opening. The insert **22** includes a body **39** sized to be snugly received within the recess **26** and a flange **37** that rests upon the support edge **24**. In accordance with one feature of the present invention, mating features are provided between the platform **18** and insert **22** that bring modularity to the TWA **10**. Moreover, these mating features allow the insert **22** to be removed from the platform **18**, even when the platform and stem **20** are engaged in a radial bone. This feature can be very beneficial during the initial wrist arthroplasty procedure. In particular, while the optimum dimensions for the TWA components can be divined prior to surgery, it is occasionally necessary to change prosthesis dimensions. For instance, several different sizes of articulating inserts **22** can be provided. In particular, the prominence of the insert can be modified, particularly the thickness of the flange **37** relative to the platform support edge **24**. The different inserts can have different flange thicknesses to accommodate different joint anatomies. During a procedure, it may be discovered that the selected TWA components are too tight or too loose relative to the surrounding soft and connective tissues. The surgeon can remove the insert and replace it with a more appropriately sized insert to achieve an optimum TWA.

In accordance with one embodiment of the invention, the mating features can constitute a snap-fit arrangement in which one element snaps into another element. In this embodiment, the mating features include an undercut **28** defined in the insert recess **26** in the platform **18**. The articulating insert **22** includes at least two flexible tabs **42** attached to the insert body **39** so that the tabs can be deflected. The flexible tabs **42** define an engagement flange **44** that engages the undercut **28** when the insert body **39** is disposed within the recess **26**. Each tab **42** can include a wedge surface **46** opposite the engagement flange **44**. This wedge surface contacts the support edge **24** of the platform to deflect the tab inward as the insert is advanced into the recess. Once the engagement flange

reaches the undercut **28**, the tab snaps outward to lock the insert within the platform.

The tabs **42** are configured to be resiliently deflected inwardly as the insert is pushed into the platform recess. This flexibility can be produced by the inclusion of slots **48** within the insert body **39**. Thus, as the tabs deflect, the slots are pinched, and when the engagement flanges **44** reach the undercuts **28**, the slots resiliently expand.

As shown in **FIG. 3**, the flexible tabs **42** are defined at opposite ends of the insert **22**. It can be appreciated that the insert can be readily mounted or engaged to the platform **18** by simply pushing the insert into the recess **26**. The wedge surfaces **46** of the tabs **42** facilitate initial insertion of the articulating insert into the platform. Once the insert **22** is lodged within the platform **18**, as shown in **FIG. 5**, the insert cannot be dislodged under normal loading of the wrist joint. Removal of the insert requires inward deflection of the flexible tabs **42** until the engagement flanges **44** are clear of the recess undercuts **28**. In one embodiment of the invention, the platform is provided with access slots **55** that extend through a portion of the recess undercuts **28**, as shown in **FIG. 6**. This slot exposes the flexible tabs **42** at the opposite sides of the platform. The tabs can be provided with tool engagement dimples **50** that are available through the access slots **55**.

A tool **60** can be provided, as shown in **FIG. 7**, for grasping the insert **22**. The tool can be a scissors-type tool with hinged arms **61**. The arms can be provided with hubs **62** that are sized to fit within a corresponding access slot **55** and contact the resilient tab within the platform. Preferably, the hubs **62** are provided with engagement posts **63** that are sized to be received within the engagement dimples **50** in the resilient tabs **42**. The engagement between the posts and dimples hold the tool **60** in engagement with the insert. The tool can be manipulated to squeeze the flexible tabs **42** together within the platform, thereby releasing the insert from the platform. Once dislodged, the insert can be

removed by the tool and a new insert can be loaded onto the platform using the same tool **60**.

In the illustrated embodiment, the insert **22** is provided with flexible tabs **42** on both sides of the insert. In this respect, the insert is universal, meaning that it can be mounted within the platform of the radial component **12** in either orientation. Alternatively, the mating feature between the platform and the insert can include comparable flexible tabs on the intermediate sides of the radial component **12**. Since these alternative mating features would be disposed on the long side of the implant, providing flexible tabs of a width less than the length of the insert may be preferable.

In yet another alternative, the insert includes only one flexible tab, provided the tab can be deflected enough to allow the insert to be pushed into and removed from the platform. In this alternative, one of the flex slots **48** can be eliminated so that the corresponding tab cannot deflect inward. In one variation on this theme, the engagement flange for the non-deflecting side of the insert can be eliminated. Instead, the non-deflecting side of the insert and the corresponding side of the platform can form a tab and slot or a tongue and groove configuration for sliding engagement between the two elements.

As an alternative, an insert **22'** can be provided, as shown in **FIG. 8**, in which the dimples **50** of the embodiment shown in **FIG. 3** are replaced by tabs or posts **50'**. These posts **50'** can be contacted and depressed against the slots **48** in a manner similar to the dimples described above. The posts **50'** preferably project beyond the slot **55** in the radial component **18** so that the posts are accessible outside the implant. With this feature, the posts can be manually depressed and the insert **22'** removed by hand, rather than with a tool.

One aspect of the embodiments shown in **FIGS. 2-6** is the use of a resilient element that can be deflected for engagement and disengagement of the articulating insert **22** to and from the platform **18** of the radial component **12**. The invention contemplates other forms of releasable resilient engagement of the two elements. For instance, as shown in **FIG. 8**, a radial component **65** can include a

platform **67** and an insert **69** that can be configured similar to the like components described above. However, in this embodiment, the mating features can include a collet or snap rivet **71** defined in the recess **72** of the platform. The insert defines a corresponding bore **73** in its body **74** that permits resilient engagement of the snap rivet. A plug **75** can be provided to close the bore when the TWA is fully implanted. The bore **73** is open at the surface of the insert to permit introduction of a tool for compressing the prongs of the collet or snap rivet **71** to permit removal of the insert.

In yet another alternative, the resiliently deflectable feature can be situated on the platform. Thus, as shown in **FIG. 10**, a radial component **78** can include a platform **80** and associated articulating insert **82**. The platform can include upwardly projecting flexible tabs **84** that engage an inner flange **86** defined in the insert. An access slot **88** can be defined in the insert **82** to allow introduction of a tool to depress the flexible tabs and release them from the inner flange of the insert.

With the embodiment shown in **FIG. 10**, the flexible tabs **84** can be integrated into a rim extending around the entire perimeter of the platform. Likewise, the inner flange **86** of the insert **82** can extend around the entire perimeter of the insert. This mating feature as modified can form a snap-fit engagement akin to the reclosable feature on Tupperware®-type food containers. A tool access opening (not shown) can be provided in either the insert or the platform to permit use of a tool to pry loose a portion of the mating engagement.

In the aforementioned embodiments of the invention, a resilient deformable mating feature is provided to permit engagement and disengagement between the insert and the platform. In additional embodiments of the invention, the mating feature includes an element separate from the platform and insert. One example is depicted in **FIGS. 11-12**. In this embodiment, a platform **90** receives an articulating insert **92**. The platform defines an angled slot **94** that extends across the width of the platform, as shown in **FIG. 12**. The insert **92** also defines an angled slot **96** that angles away from the slot **94**. A pin **98** is

configured to fit snugly within at least the slot **96** in the insert and to be able to pass freely between the two slots **94**, **96**. The platform defines openings **101** through its side walls **100** so that the pin **98** can pass through both the insert **92** and the platform side walls **100**, as shown in **FIG. 12**. When the pin is in the position shown in **FIG. 11**, the insert is locked to the platform.

The ends **99** of the pin **98** are accessible outside the platform so that the pin can be manipulated from the slot **96** in the insert to the slot **94** in the platform. When the pin is moved into the angled slot **94**, it is clear of the insert so that the insert can be removed from the platform. The angled slot **96** in the articulating insert **92** can be arranged to efficiently capture the pin **96** within the insert. In addition, the slot can be configured to resiliently grip the pin. The opening **101** in the side walls **100** of the platform can emulate the configuration of the angled slot **96**. It is of course understood that the opening **101** must communicate with the angled slot **94** in the platform.

Following a similar approach is the embodiment shown in **FIGS. 13-14**. In this embodiment, a platform **110** receives an insert **112**. The platform includes a cam lock **114** that is pivotably mounted at a pivot point **116** within an opening **120** in the platform. This opening **120** coincides with a dimple or recess **122** defined in the insert **112**, wherein the recess is aligned with the opening when the insert is mounted within the platform.

The cam lock **114** includes a cam surface **118** that is configured so that the cam surface is wholly disposed within the opening **120**, as shown in **FIG. 13**, to allow placement of the insert into the platform. The cam lock **114** includes an arm **124** that can be used to rotate the lock about its pivot point **116** so that the cam surface **118** now extends through the opening **120** and into the recess **122**. In this position, the cam lock arm **124** can be disposed within an indentation **126** in the platform so that the cam lock is essentially flush with the platform outer surface. In order to accomplish this motion, the cam lock is preferably eccentrically mounted and the cam surface oblong in shape.

While the invention has been illustrated and described in detail in the drawings and foregoing description, the same should be considered as illustrative and not restrictive in character. It is understood that only the preferred embodiments have been presented and that all changes, modifications and further applications that come within the spirit of the invention are desired to be protected.